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Betz

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(54) **AUTOMATICALLY ADJUSTING LIGHT SHELF AND METHOD OF USE**

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G01S 3/784	(2006.01)
F24J 2/38	(2014.01)
F21S 11/00	(2006.01)
F24J 2/06	(2006.01)

(52) **U.S. Cl.**

CPC ***G01S 3/784*** (2013.01); ***F21S 11/007*** (2013.01); ***F24J 2/02*** (2013.01); ***F24J 2/38*** (2013.01); *F24J 2/06* (2013.01); *H02S 20/32* (2014.12)

(58) **Field of Classification Search**

USPC 250/201.1–201.3, 203.1–203.4; 359/592, 596, 597; 126/574–575

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,013,885	A	3/1977	Blitz	
4,225,781	A *	9/1980	Hammons	250/203.4
4,349,733	A	9/1982	Beam	
5,493,824	A *	2/1996	Webster et al.	52/200
5,517,358	A *	5/1996	Dominguez	359/592
6,988,525	B2	1/2006	Moulton	
7,417,397	B2	8/2008	Berman	
8,116,004	B2	2/2012	Griffiths	
2007/0297058	A1 *	12/2007	Briee et al.	359/597
2009/0084431	A1 *	4/2009	Briee et al.	136/246
2010/0254011	A1 *	10/2010	Griffiths	359/597

OTHER PUBLICATIONS

U.S. Appl. No. 12/421,967, filed Oct. 14, 2010, Hyatt, pp. 1, 16, 17.

* cited by examiner

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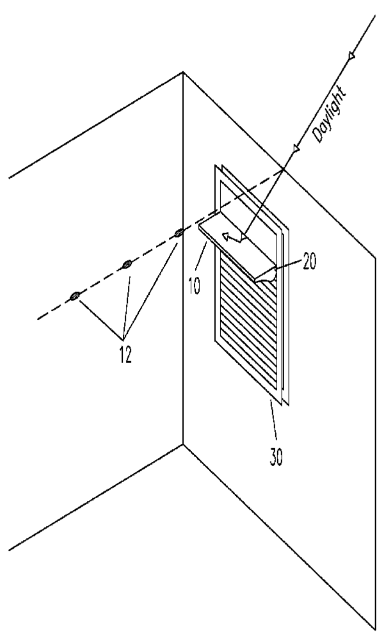
(57) **ABSTRACT**

An automatically adjusting light shelf has a circuit of components used to measure light levels within a space; a light shelf hinged to a window assembly, used to reflect light entering the space; and a rotation device used to alter the light entering the space by rotating the light shelf. The light levels are measured using light sensors having a capacitive component and phototransistor in parallel with one another, a microcontroller, and optionally, a clock. The automatic operation of the light shelf can be overridden for manual operation. A method of using the automatically adjusting light shelf includes the steps of measuring a differential between the light levels reaching the light sensors; determining a direction to rotate the light shelf to alter the light; and rotating the light shelf so that the reflected light is optimized within the space.

17 Claims, 4 Drawing Sheets



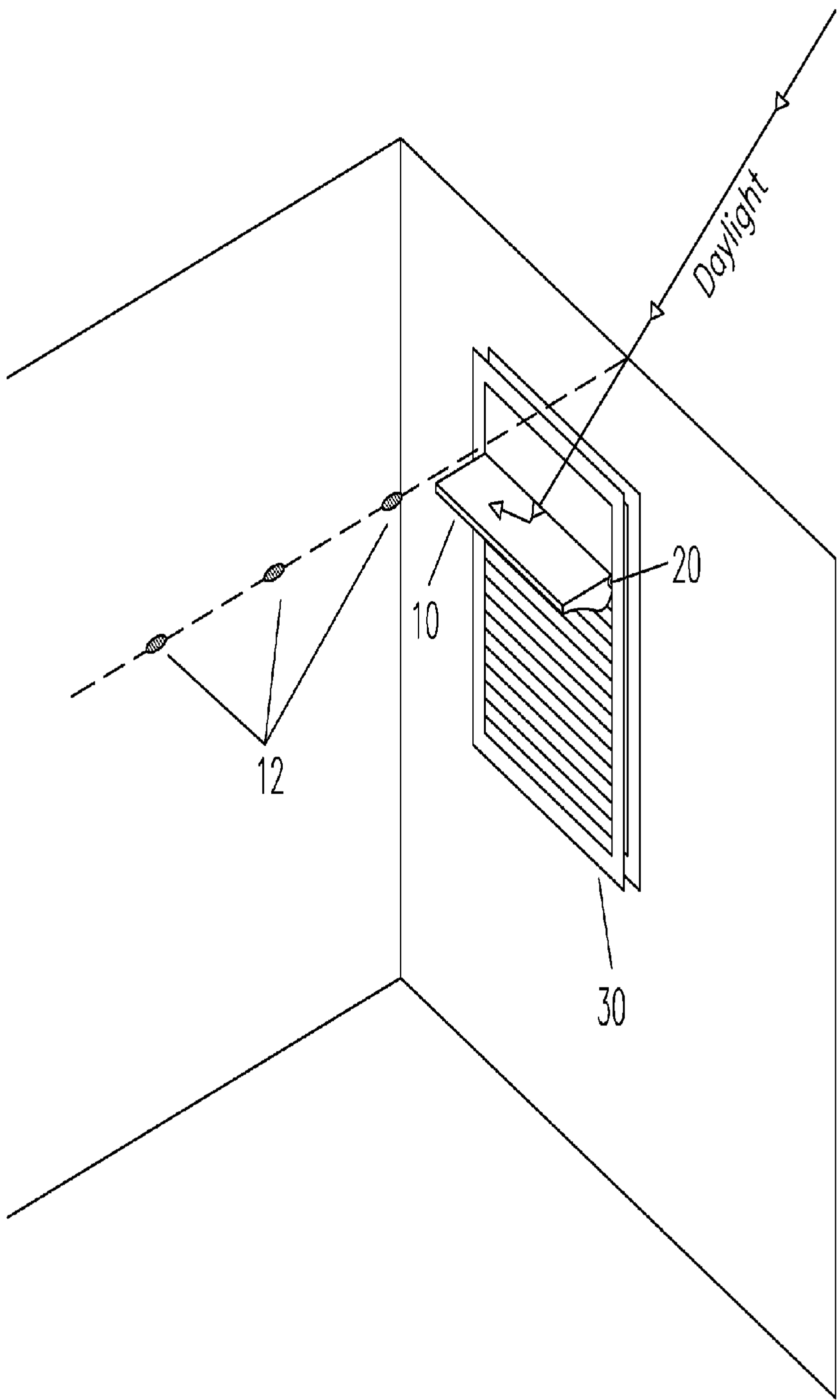


FIG. 1

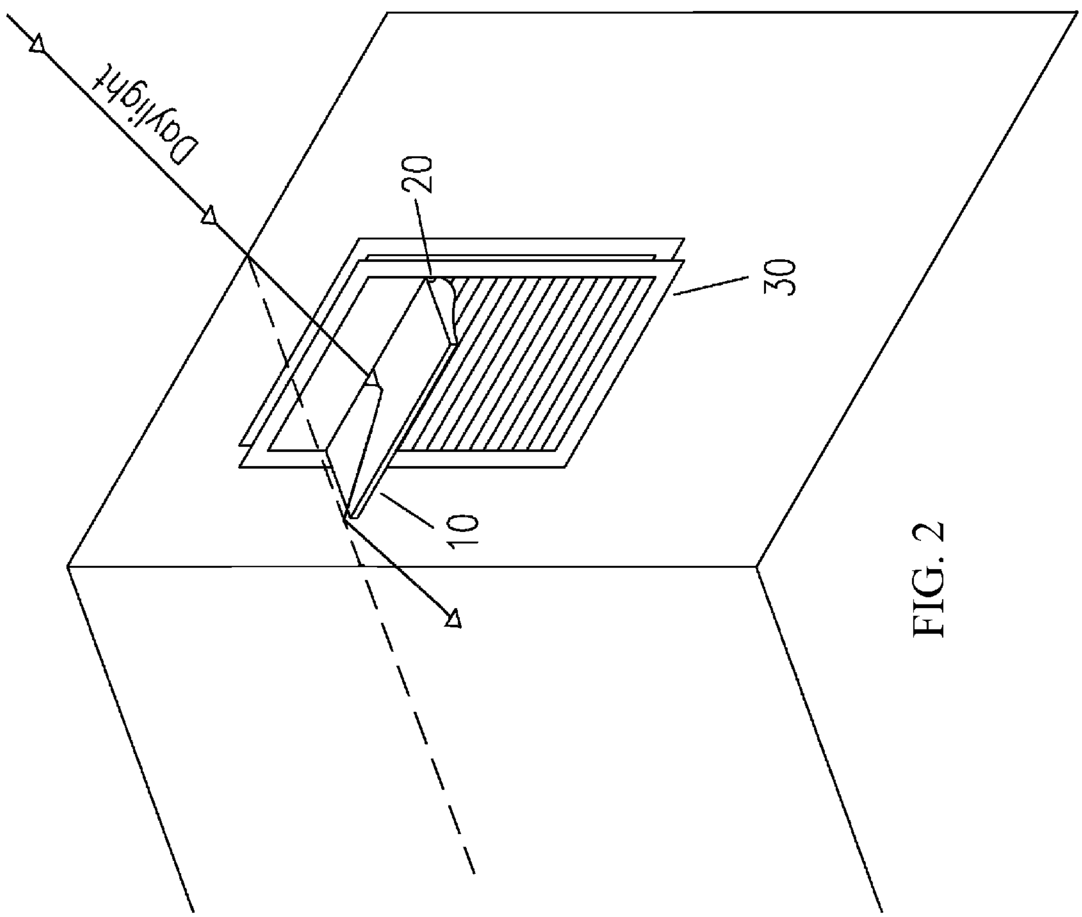


FIG. 2

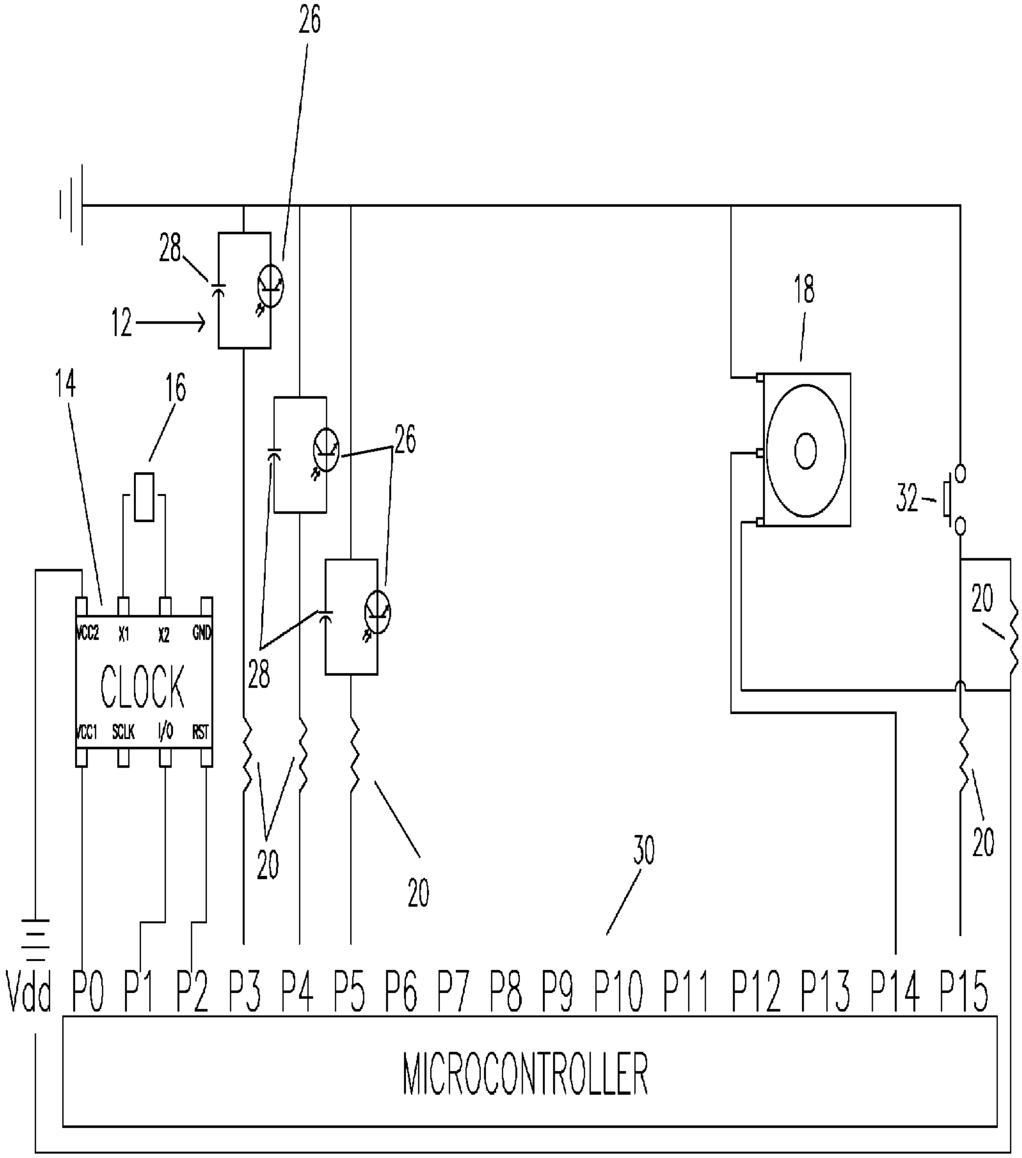

26
28
12
14
16
18
26
32
VCC2
X1
X2
GND
CLOCK
VCC1
SCLK
I/O
RST
28
20
20
20
20
30
Vdd
P0
P1
P2
P3
P4
P5
P6
P7
P8
P9
P10
P11
P12
P13
P14
P15
MICROCONTROLLER

FIG. 3

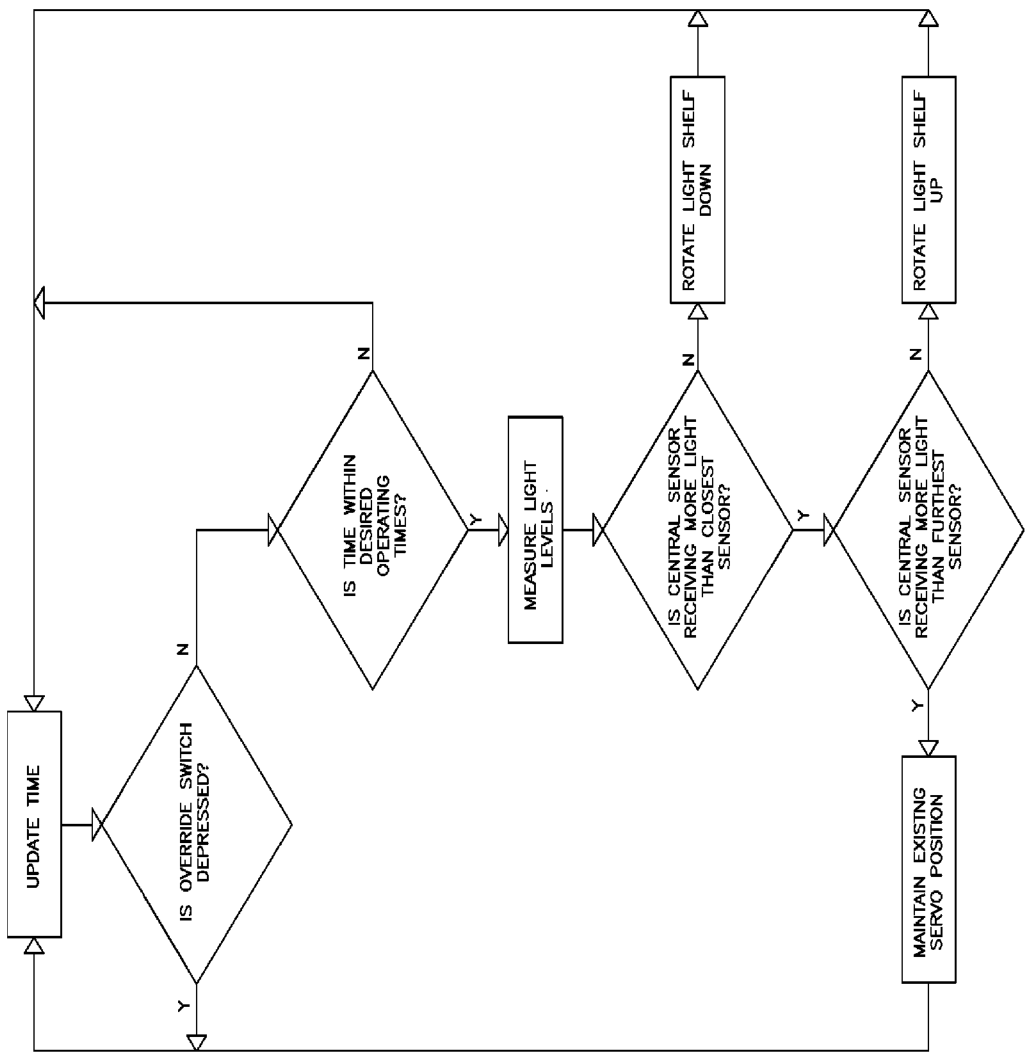

UPDATE TIME
IS OVERRIDE SWITCH DEPRESSED?
Y
N
IS TIME WITHIN DESIRED OPERATING TIMES?
Y
N
MEASURE LIGHT LEVELS
IS CENTRAL SENSOR RECEIVING MORE LIGHT THAN CLOSEST SENSOR?
Y
N
ROTATE LIGHT SHELF DOWN
IS CENTRAL SENSOR RECEIVING MORE LIGHT THAN FURTHEST SENSOR?
Y
N
ROTATE LIGHT SHELF UP
MAINTAIN EXISTING SERVO POSITION

FIG. 4

AUTOMATICALLY ADJUSTING LIGHT SHELF AND METHOD OF USE

CROSS-REFERENCE TO RELATED APPLICATIONS

BACKGROUND

Prior-Art

The following is a tabulation of some prior art that presently appears relevant:

U.S. Patents			
Pat. No.	Kind Code	Issue Date	Patentee
4,013,885	A1	1977-03-22	Blitz, D
4,225,781	A1	1980-09-30	Hammones, B
4,349,733	A1	1982-09-14	Beam, B
6,988,525	A1	2004-12-23	Moulton, P
7,417,397	A1	2009-01-22	Berman, J
8,116,004	A1	2010-10-07	Griffiths, R
12/421,967	A1	2010-10-14	Hyatt, L

As world populations grow and put a greater strain on the availability of resources there is an increasingly focused effort on sustainable, energy efficient designs, particularly when it comes to architecture, as buildings are the single largest user of energy within the United States. Although the specific energy profile of a building depends largely on its particular use, space lighting consistently ranks within the top slots of energy expenditure. While lighting technology continues to advance and produce more efficient means of artificial lighting, no fixture will ever be able to overtake the innate sustainable features of properly exploited natural light within a structure.

One area of lighting design that has been able to effectively exploit natural daylight is the use of light shelves. A light shelf is essentially a horizontal opaque surface mounted to a window frame, where a portion of the window glazing extends above the light shelf. The diffuse or specular surface of the light shelf effectively reflects the sunlight to the upper regions of the room. If the ceiling is designed with a sufficient reflectivity, the light is then redirected to the workspace as free area lighting, whereas a design without light shelves would have the sunlight instead absorbed by the carpet. By combining the window fenestration with a shading element below the light shelf, free daylighting can be harvested while still avoiding unnecessary glare.

Some of the current designs, such as U.S. Pat. No. 8,116,004 by Griffiths R. T., approach the manufacturability and design deficiencies as a means to broaden the use of light shelves. Such designs do address the manufactured surface of the light shelf as a means of controlling the availability of light, but do little to have any automatic control as a means of compensating for differing lighting conditions.

One of the drawbacks of light shelves is their inability to adjust to differing lighting conditions to maximize their effect. In the mid to extreme latitudes, the sun's angle to the horizon changes throughout the seasons which can affect how the light is reflected into the space. For example, in the winter when the sun is at a low relative angle, the daylight would be reflected at a relatively small angle of incidence having the effect of the daylighting maximized deep within the space. Conversely, in the summer when the sun is at a high angle, most of the light would be reflected to an area near the window leaving the interior spaces with less than optimal daylighting.

There have been some attempts to remedy this effect on a light shelf. U.S. Pat. No. 6,988,525 by Mouton P., explains an adjustable light shelf design. However, there are no automatic controls present in this apparatus. Whenever it is left to an occupant to manually adjust an apparatus, the operation typically deviates from the optimum as the person may not always be cognizant of the need to adjust the device, and furthermore, may not be able to take time away from the present task to do so. This invariably lends itself to sub-optimal operation and often means the apparatus is left in a more disadvantageous position than if the adjustment option was excluded. There are methods of automatic shade controls, such as U.S. Pat. No. 7,417,397 by Berman et. Al., but this is not intended for use with light shelves. While this patent uses sensors and a controller, its aim is to provide shade position to facilitate a desired light level within the space. Since it is not used with light shelves, the direction of the light entering the space is not controlled into the most advantageous spot to be used by the workspace. This can lead to various lighting conditions throughout the sun's position, which may lead to artificial lighting being used even when there is sufficient daylighting available. In fact, many audits show that occupants will unwittingly subject themselves to overlit conditions in order to even out the lighting throughout the space. There are some light shelf devices, such as the one detailed by U.S. Pat. No. 8,116,004 by Griffiths, that details a light shelf system but does not have an adequate means of automatically orienting the device for the preferred lighting condition. Other designs, such as U.S. patent application Ser. No. 12/421,967 by Hyatt, feature adjustable light shelves but they are manual designs specified to simply enhance the robustness of the shelf and not for optimizing interior lighting.

There are other devices not specifically used for light shelves that have reorienting methods that respond to sunlight but are not particularly well suited to light shelf applications. U.S. Pat. No. 4,013,885 by Blitz is a sun tracker that uses an imaging tracker located directly behind the collecting device that would be awkwardly placed within the living space if used in a light shelf application. U.S. Pat. No. 4,225,781 by Hammonds uses a pyramid-shaped array of sensors that would not work well for a light shelf application, which necessitates the sensors being on the same plane such as on a ceiling in the preferred embodiment. U.S. Pat. No. 4,349,733 by Beam details a sun tracker that uses a means of orientation that seeks uniformly illuminated photo sensors, while the differential method used in this device makes it easier to orient the device to maximize light in the most advantageous point in the space by placing the central sensor where the maximum light point is desired, as opposed to manipulating all of the sensor locations so that they are equally illuminated when the light is in the proper placement. None of the above devices in this paragraph utilizes a clock function to determine preferred no operating times, nor do they apply to light shelves.

Other embodiments could be useful for other purposes than architectural space lighting. This could include any apparatus that requires directed daylight on a specific point regardless of source orientation to the reflective surface. An example could be a solar thermal application where the light is required to be continuously focused on a specific area that needs heating, or a solar application where reflected light is used by photovoltaic cells to produce electricity.

SUMMARY

In accordance with one embodiment, an automatically adjusting light shelf comprises of a light shelf, a plurality of light sensors, an astronomical clock, a servomotor, an override switch, and a microcontroller.

Accordingly, several advantages of one or more aspects are as follows: to provide an automatically adjusting light shelf, that uses a plurality of light shelves to communicate with a servomotor via a microcontroller to find the best rotational angle of the light shelf as a means of optimizing the placement of the light reflected off of the light shelf surface, an astronomical clock that utilizes an algorithm to determine the optimal operating times, and a switch that will allow an end-user the option to override predetermined operation. Other advantages of one or more aspects will be apparent from a consideration of the drawings and ensuing description.

DRAWINGS

Figures

FIG. **1** shows the light shelf system, according to an embodiment of the present invention;

FIG. **2** shows the light shelf system, according to an embodiment of the present invention;

FIG. **3** shows an electrical schematic of the light shelf system having three light sensors, a clock, and an override switch, according to an embodiment of the present invention;

FIG. **4** shows a flow diagram for the microcontroller sequence of operations, according to an embodiment of the present invention.

The sequence listing shows one embodiment of a program for the microcontroller to run the system using PBASIC programming language. A portion of this particular embodiment uses a segment of code from the Parallax Corporation for use with their DS1302 clock component module.

Drawings-Reference Numerals	
10 light shelf	12 light sensors
14 clock	16 timing crystal
18 servomotor	20 hinge
22 power source	24 microcontroller
26 resistor	26 phototransistor
28 capacitor	30 window assembly
32 switch	

DETAILED DESCRIPTION

FIGS. **1**, **2**, **3**, and **4**

One embodiment of the apparatus is illustrated in FIG. **1**. A light shelf **10** is mounted to the window assembly **30** so that light is reflected off the light shelf **10** into the adjacent space. In the embodiment shown, a plurality of light sensors **12** are placed in an orientation in the same direction at which the light shelf **12** juts into the space. A servomotor **18** is attached to the hinge **20** of the light shelf **12**.

In an alternative embodiment, as shown in FIG. **2**, the light shelf **10** directs the light entering the space to a surface in an upper region of the space having a reflective quality. The reflective quality of the surface in the upper region of the space then re-directs the light to a location within the space.

FIG. **3** shows an electrical schematic of one embodiment. The microcontroller **24** contains 16 pin locations labeled P**0**-P**15**. Other embodiments can be arranged with different configurations and the pin connections in this particular embodiment are arbitrary. As such, other embodiments can use alternate component arrangements.

A clock **14** utilizes P**0**, P**1**, and P**2** for operation. The clock **14** is attached to a timing crystal **16** to keep proper time after the initial time parameters are programmed. P**3**, P**4**, and P**5** are each connected to the light sensors **12** in series with a resistor **26**. In this embodiment, light sensors **12** comprise of a phototransistor **34** connected in parallel to a capacitor **36**. However, other embodiments can use other means of light sensing and measurement. The microcontroller **24** is also connected to the servomotor **18** which drives the hinge **20** of the light shelf in this embodiment, facilitating rotation of the light shelf **10** about the axis of the hinge **20**. A switch **32** is connected to the microcontroller **24** which allows for user override functionality in this embodiment. A power source **22** is connected to the microcontroller **24** to facilitate operation.

Additional Embodiments

There are a number of alternate arrangements of light sensors **12** that would be capable of performing the necessary light differential readings. Other embodiments could use ambient sensors to determine operational times, either in lieu or in conjunction with the clock **14**. Some embodiments may omit the clock **14** altogether, depended on the desired operation. It may be desirable to have an embodiment with an alarm function to denote when the system is not operating in the most advantageous manner. Other embodiments are capable of performing the same necessary functions of the basic system operation.

Operation—FIGS. **1**, **2**, **3**, and **4**

The operation of the automatically adjusting light shelf begins with the appropriate time being programmed into the microcontroller **24**. After this point, the clock **14** will automatically track the current time and continuously update. Once the system has determined that the current time is within the desired operational time periods, it will measure the light levels being reflected off of the light shelf **10** onto the light sensors **12**.

Most embodiments will have a predetermined light sensor **12** placed in a location that optimizes the light within the space. It may be in the center of the room to maximize the light throughout the area or it may be placed strategically over an area that needs additional task lighting. The microcontroller **24** will measure the light levels on the individual light sensors **12** and determine which way the servomotor **18** should rotate in order optimize the desired lighting characteristics. As the servomotor **18** rotates, it causes the light shelf **10** to adjust about its hinge **20** that then optimizes the way that the light is reflected into the space. The light shelf **10** will continue to operate in this manner, measuring light levels and adjusting the reflected light at predetermined intervals until the time registered is no longer within the desired operating time periods.

ADVANTAGES

From the description above, a number of advantages from one or more aspects of various embodiments of the photoresponsive automatic solar panel cleaner become evident:

(a) The light shelf has a hinge assembly that allows it to be rotated to the most advantageous orientation for use.

(b) The use of measuring different intensities of incident light striking the light sensing elements in the embodiment allows the light shelf to be placed in a quantifiably optimized orientation.

(c) The use of a microcontroller, in conjunction with a servomotor and light sensing elements allows for the position of the light shelf to be adjusted continuously without direct user interface.

(d) The availability of a switch override in this embodiment allows for the user to manually adjust the light shelf position in the event that the desired position differs from the programmed optimized location.

(e) The use of a clock within this embodiment allows for the operational times to be optimized so that the light shelf does not operate unnecessarily during times when additional light is not needed, thus saving energy.

The embodiment in FIG. **3** shows each of the light sensors as a resistive-capacity circuit, the clock assembly, and the servomotor assembly. The sequence listing shows an embodiment of a program written in PBASIC that uses a table lookup function in conjunction with the clock to cause the light shelf to operate only during the times between sunrise and sunset, so as to avoid operation due to night lighting. Algorithms could alternatively be programmed for different operational time schemes, such as only operating during specified work schedules of the occupants.

CONCLUSIONS, RAMIFICATIONS, AND SCOPE

Accordingly, the reader will see that the automatically adjusting light shelf can be used as a means to optimize the natural daylighting within a space, leading to increased occupant comfort and productivity as well as decreased energy usage. Using light sensors to detect the current lighting conditions, the differential light measurements between the light sensors is used to determine the best orientation of the light shelf, which is rotated about a hinge to place the daylighting where it is most needed within the space.

Although the description above contains specific descriptions, these should not be interpreted as limiting the scope of the embodiments but merely as a way of providing illustrations of possible embodiments. For example, more than three light sensors can be used, or alternate methods of light sensing can be employed. Thus the scope of the embodiments should be determined by the appended claims and their appropriate legal equivalents, rather than the specific representations previously defined. The following is one embodiment of a control sequence written in PBASIC language.

```
' {$STAMP BS2}
' {$PBASIC 2.5}

time1              VAR    Word
time2              VAR    Word
time3              VAR    Word
Light_Threshold    CON    20000
Diff1              VAR    Word     'measures different light
                                   'levels between center and
                                   right sensor
Diff2              VAR    Word     'measures different light
                                   'levels between center and
                                   left sensor
position           VAR    Word
counter            VAR    Word
time_limit         CON    10       'sets length of time between
                                   'cycles in minutes
Sunrise            VAR    Word
Sunset             VAR    Word
Time               VAR    Word
'Define I/O pins and RTC variables
Clk CON 0
Dta CON 1
RTCCS CON 2
RTCCmd VAR Byte
Value VAR Byte
Seconds VAR Byte
Minutes VAR Byte
Hours VAR Byte
Date VAR Byte
Month VAR Byte
Day VAR Byte
Year VAR Byte
Idx VAR Byte
'Define RTC Command Constants
SecReg CON %00000
MinReg CON %00001
HrsReg CON %00010
DateReg CON %00011
MonReg CON %00100
DayReg CON %00101
YrReg CON %00110
CtrlReg CON %00111
TChgReg CON %01000
BrstReg CON %11111
'Define Days-Of-Week, Months and AM/PM text.
'All text is stored in EEPROM with a binary 0
'as the ENd-of-text character
Sun DATA "Sun",0
Mon DATA "Mon",0
Tue DATA "Tues",0
Wed DATA "Wednes",0
Thu DATA "Thurs",0
```

-continued

```
Fri DATA "Fri",0
Sat DATA "Satur",0
Jan DATA "January",0
Feb DATA "February",0
Mar DATA "March",0
Apr DATA "April",0
May DATA "May",0
Jun DATA "June",0
Jul DATA "July",0
Aug DATA "August",0
Sep DATA "September",0
Oct DATA "October",0
Nov DATA "November",0
Dcm DATA "December",0
AM DATA " AM",0
PM DATA " PM",0
'Set I/O pin states and directions
OUTS = %0000000000000000 'All logic low
DIRS = %0000000000000111 'I/O 0,1 and 2 are output, rest are input
Initialize:
'NOTE: Date must be set only once for every power-up of DS1302 chip.
Day = $01 'Sunday
Month = $01 'January
Date = $28 '28th
Year = $12 '2012
Hours = $12 '12:00 PM (in 24-hour mode)
Minutes = $30
Seconds = $00
GOSUB SetTimeAndDate

'***intitialize servo****
position = 500

DO UNTIL IN15 = 1
   GOSUB ReadRTCBurst
   GOSUB GetSunriseSunset
   GOSUB PrintLongDate
   Time = (100*((Hours>>4)*10+(Hours & $oF)))
        + ((Minutes>>4)*10+(minutes & $0F) 'converts HEX time into DEC
   'GOSUB Print24HourTime
   counter = 0
   IF Time > Sunrise AND Time < Sunset THEN GOSUB Measure_Light
                                              'measure light intensity on
                                              'each sensor
   GOSUB Adjust_Shelf                         'adusts light shelf if center
                                              'sensor
                                              'is not receiving the most
                                              'light
   DO
   PAUSE 60000                                 'each pause session is one min
   counter = counter + 1
   LOOP UNTIL counter = time_limit              'pause until the number of
                                                'minutes
                                                'between of time shelf cycles
                                                'is met
LOOP

Measure_Light:

HIGH 4
   PAUSE 3                                      'measures left sensor
   RCTIME 4,1,time1
   PAUSE 1000

   HIGH 5                                       'measures center sensor
   PAUSE 3
   RCTIME 5,1,time2
   PAUSE 1000

   HIGH 6                                       'measures right sensor
   PAUSE 3
   RCTIME 6,1,time3
   PAUSE 1000

   Diff1 = time2 - time1                        'measure difference between
                                                'center and left sensor
   Diff2 = time2 - time3                        'measure difference between
                                                'center and right sensor
   IF Diff1 > Light_Threshold THEN              'Compensates for negative
```

-continued

```
difference
    Diff1 = 0                                   'between sensor comparison
  ENDIF
  IF Diff2 > Light_Threshold THEN
    Diff2 = 0
  ENDIF

  RETURN

Adjust_Shelf:
                                                'if right sensor receives
                                                'more light than center
                                                'sensor rotate shelf CW
  IF Diff1 > Diff2 THEN
    IF Diff1 >= 20 THEN position = position + 5

                                                'if left sensor receives
                                                'more light than center
                                                'sensor rotate shelf CCW
  ELSEIF Diff2 > Diff1 THEN
    IF Diff2 >= 20 THEN position = position − 5
  ENDIF
  PULSOUT 14, position
  RETURN
'=================== DS1302 Real-Time Clock Subroutines
PrintLongDate:
'Print long date format on debug screen
LOOKUP Day-1,[Sun,Mon,Tue,Wed,Thu,Fri,Sat],Idx
GOSUB PrintIt
LOOKUP Month-1,[Jan,Feb,Mar,Apr,May,Jun,Jul,Aug,Sep,Oct,Nov,Dcm],Idx
GOSUB PrintIt
'NOTE: The following line prints the proper 4-digit year for the years
'1990 through 2089
RETURN

PrintShortDate:
'Print short date format on debug screen
RETURN
Print12HourTime:
'Print 12-hour time format on debug screen
'NOTE: The DS1302 has 12 and 24 hour time-keeping modes (bit 7 of
HrsReg
'sets 12/24 mode and bit 5 indicates AM/PM or 20+ hours). For purposes
'of this example, we're using 24 hour mode only, and converting it to
'12-hour in the next two lines below.
DEBUG DEC2 12-(24-(Hours.HIGHNIB*10+Hours.LOWNIB)//12),":",HEX2
Minutes,":",HEX2 Seconds,CR
LOOKUP Hours/$12,[AM,PM],Idx
GOSUB PrintIt
'GOSUB GetSunriseSunset
'DEBUG ? Sunrise, CR
'DEBUG ? Sunset, CR
RETURN

Print24HourTime:
'Print 24-hour time format on debug screen
'for checking set time
DEBUG HEX2 Hours,":",HEX2 Minutes,":",HEX2 Seconds, CR
RETURN

PrintIt:
'Prints zero (0) terminated text from EEPROM
READ Idx,Value 'Get next character
IF Value = 0 THEN Finished 'Make sure it's not a binary 0
DEBUG Value 'Display it on screen
Idx = Idx + 1
GOTO PrintIt
Finished:
RETURN

WriteRTCRAM:
'Write to DS1302 RAM Register
HIGH RTCCS
SHIFTOUT Dta, Clk, LSBFIRST, [%0\1,RTCCmd\5,%11\2,Value]
LOW RTCCS
RETURN

WriteRTC:
'Write to DS1302
```

-continued

```
HIGH RTCCS
SHIFTOUT Dta, Clk, LSBFIRST, [%0\1,RTCCmd\5,%10\2,Value]
LOW RTCCS
RETURN

ReadRTCBurst:
'Read all time-keeping registers in one burst
HIGH RTCCS
SHIFTOUT DTA, Clk, LSBFIRST, [%1\1,BrstReg\5,%10\2]
SHIFTIN DTA, Clk, LSBPRE, [Seconds,Minutes,Hours,Date,Month,Day,Year]
LOW RTCCS
RETURN

ReadRTCRAM:
'Read DS1302 RAM Register
HIGH RTCCS
SHIFTOUT DTA, Clk, LSBFIRST, [%1\1,RTCCmd\5,%11\2]
SHIFTIN DTA, Clk, LSBPRE, [Value]
LOW RTCCS
RETURN
SetTimeAndDate:
'Write time values into all time-keeping registers, being sure to clear
'the write-protect bit in CtrlReg before the write, and set the
'write-protect bit after the write
FOR Idx = 0 TO 8
LOOKUP Idx,[0,Seconds,Minutes,Hours,Date,Month,Day,Year,128],Value
LOOKUP Idx,[CtrlReg, SecReg, MinReg, HrsReg, DateReg, MonReg, DayReg,
YrReg, CtrlReg],RTCCmd
GOSUB WriteRTC
NEXT
RETURN
'*********************SETTING SUNSET/SUNRISE**************************
GetSunriseSunset:
'Converts HEX Year into Decimal form and looks up relevant months for
´2012
IF (year>>4)*10 + (year & $0F) = 12 THEN
'Converts HEX Month into decimal and checks if it is January
  IF (Month>>4)*10 + (Month & $0F) = 01 THEN
'looks up sunrise times for January dates and assigns value
    LOOKUP (Date>>4)*10 + (Date & $0F), [0804, 0804, 0804, 0804, 0804,
0804, 0804, 0804, 0803, 0803, 0803, 0803, 0802, 0802, 0802, 0801, 0801,
                 0800, 0759, 0759, 0758, 0758, 0757, 0756, 0755, 0754,
0754, 0753, 0752, 0751, 0750], Sunrise
'allows the Measure__Light subroutine to occur no earlier than 2 hours
before sunrise
    sunrise = sunrise + 200
'looks up sunset times for January dates and assigns value
    LOOKUP (Date>>4)*10 + (Date & $0F), [1713, 1714, 1715, 1716, 1717,
1718, 1719, 1720, 1721, 1722, 1723, 1724, 1725, 1726, 1727, 1728, 1730,
                  1731, 1732, 1733, 1735, 1736, 1737, 1738, 1740, 1741,
1742, 1743, 1745, 1746, 1747], Sunset
'allows the Measure__Light routine to occur no later than 2 hours before
sunset
    sunset = sunset - 200
'Converts HEX Month into decimal and checks if it is February
  ELSEIF (Month>>4)*10 + (Month & $0F) = 02 THEN
'looks up sunrise times for February dates and assigns values
     LOOKUP (Date>>4)*10 + (Date & $0F),
[0749,0748,0747,0746,0745,0743,0742,0741,0740,0739,0737,0736,0735,0733,
0732,0731,0729,
0728,0726,0725,0723,0722,0720,0719,0717,0716,0714,0713,0711], Sunrise
'looks up sunset times for February dates and assigns values
     LOOKUP (Date>>4)*10 + (Date & $0F),
[1749,1750,1751,1753,1754,1755,1756,1758,1759,1800,1802,1803,1804,1805,
1807,1808,1809,1811,
1812,1813,1814,1816,1817,1818,1819,1821,1822,1823,1824], Sunset
  ENDIF
ENDIF
RETURN
'ELSEIF Year = 13 THEN     ///For brevity's sake, the additional years
                            ´have been omitted.
  'IF Month = Jan           ///Full version has all months of all
                            ´years up to 2086 for DS1302 clock
    'LOOKUP Date
  'endif
'ENDIF
```

What is claimed is:

1. An automatically adjusting light shelf, comprising:
a. a circuit of components configured to measure a plurality of light levels within a space, wherein the circuit of components comprises:
i. one or more light sensors, comprising:
1. a capacitive component; and
2. a phototransistor in parallel with the capacitive component, wherein the plurality of light levels reaching the one or more light sensors results in measurable differences in a resistive-capacitive time constant of the one or more light sensors; and
ii. a microcontroller, configured to measure the plurality of light levels reaching the one or more light sensors;
b. a light shelf hingedly connected to a window assembly, the light shelf having a one and only undivided reflective surface configured to reflect a light entering the space, wherein the one or more light sensors are configured to detect the light being reflected into the space; and
c. a rotation device configured to rotate the light shelf, wherein a rotation of the light shelf affects the light entering the space, and wherein the microcontroller is in communication with the rotation device, wherein the microcontroller is configured to measure the plurality of light levels reaching the one or more light sensors and to determine a rotation of the light shelf.

2. The automatically adjusting light shelf of claim **1**, wherein the rotation device is a servomotor.

3. A method of using the automatically adjusting light shelf of claim **1**, comprising the steps of:
measuring a differential between the plurality of light levels reaching one or more light sensors within the space;
determining a direction to rotate the light shelf to alter a lighting condition within the space; and
rotating the light shelf so that the reflected light is optimized for a desired outcome.

4. The automatically adjusting light shelf of claim **1** wherein the circuit of components further comprises a manually operated switch connected to the microcontroller, configured to override an automatic operation.

5. The automatically adjusting light shelf of claim **1**, wherein the circuit of components further comprises a clock configured to be referenced by the microcontroller for system operations.

6. The automatically adjusting light shelf of claim **1**, wherein the one or more light sensors are co-planar.

7. The automatically adjusting light shelf of claim **1**, further comprising a shading element below the light shelf.

8. The method of using the automatically adjusting light shelf of claim **3**, further comprising the steps of:
tracking a current time using a clock;
programming a set of desired operational time parameters into a microcontroller;
providing a regular updated time reading from the clock to the microcontroller; and
referencing the current time against the set of desired operational time parameters, wherein the light shelf is rotated only if the updated time is within the set of desired operational time parameters.

9. An automatically adjusting light shelf, comprising:
a. a circuit of components configured to measure a plurality of light levels within a space;
b. a light shelf having a one and only undivided reflective surface configured to reflect a light entering the space, wherein the light shelf is hingedly connected to a window assembly; and
c. a rotation device in communication with the circuit of components, the rotation device being configured to rotate the light shelf, wherein the circuit of components is configured to detect the reflected light, and wherein a rotation of the light shelf affects the light entering the space, wherein the light shelf is configured to direct the light entering the space to a surface in an upper region of the space having a reflective quality, wherein the reflective quality of the surface in the upper region of the space is configured to re-direct the light to a location within the space.

10. The automatically adjusting light shelf of claim **9**, wherein the circuit of components comprises:
a. one or more light sensors, each light sensor being configured to detect a light level; and
b. a microcontroller configured to measure the plurality of light levels reaching the one or more light sensors and to determine a rotation of the light shelf.

11. The automatically adjusting light shelf of claim **9**, further comprising a shading element below the light shelf.

12. The automatically adjusting light shelf of claim **9**, wherein the rotation device is a servomotor.

13. A method of using the automatically adjusting light shelf of claim **9**, comprising the steps of:
measuring a differential between the plurality of light levels reaching one or more light sensors within the space;
determining a direction to rotate the light shelf to alter a lighting condition within the space; and
rotating the light shelf so that the reflected light is optimized for a desired outcome.

14. The method of using the automatically adjusting light shelf of claim **13**, further comprising the steps of:
tracking a current time using a dock;
programming a set of desired operational time parameters into a microcontroller;
providing a regularly updated time reading from the clock to the microcontroller; and
referencing the current time against the set of desired operational time parameters, wherein the light shelf is rotated only if the updated time is within the set of desired operational time parameters.

15. The automatically adjusting light shelf of claim **10**, wherein the circuit of components further comprises a manually operated switch connected to the microcontroller, the manually operated switch being configured to override an automatic operation of the light self.

16. The automatically light shelf of claim **10**, wherein the circuit of components comprises a clock configured to be referenced by the microcontroller for system operations.

17. The automatically adjusting light shelf of claim **10**, wherein the one or more light sensors are co-planar.

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